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Japan Report

SCIENCE AND TECHNOLOGY

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JAPAN REPORT
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BIOTECHNOLOGY

STATE OF BIOTECH INDUSTRY IN U.S., JAPAN COMPARED

Tokyo TSUSAN JANARU in Japanese Feb 87 pp 82-85

[Discussion by Frank E. Young, director of the FDA; Kei Arima, chairman of the Fermentation Industry Association [hakko kogyo kyokai]; and Naomichi Suzuki, chief of MITI's Basic Industries Bureau]

[Text] Biotechnology...it is said that this will form the nucleus of industry in the 21st century. With a view to promoting the practical development of biotechnology, the "Tokyo International Biotech Fair '86" was held at Sunshine City in Tokyo's Ikebukuro district for 5 days, October 15-19 1986, under the auspices of the Bioindustry Promotion Operation Division [baioindasutori shinko jigyobu] (BIDC) of the Fermentation Industry Association (foundation). Through the cooperation of industry, academia and government, it was a biotechnology exhibition on the largest global scale, at which 215 prominent, bio-related enterprises gathered, including 78 overseas firms from 14 nations. Furthermore, at the fair symposia were also held by a total of 97 scholars and enterprise experts, 52 from Japan and 45 from overseas, and enthusiastic views were exchanged. Director Young, whom we welcomed to this discussion, also came to Japan as a lecturer at the fair.

Suzuki: Thank you, Director Young, for taking time out from your busy schedule to attend today.

Thanks to your help, I think the Tokyo Biotech Fair was a success, but what did you think of it?

Young: Due to the fact that they took the initiative in holding this sort of biotech fair at a very early period even in global terms, I am astonished at the foresight of the organization which hosted the fair, and MITI which actively supported it.

The main point of success of this time's biotech fair is that an extremely wide range of fields was covered, and I think it is significant that universities, research facilities, the government and industrial circles gathered together. Furthermore, I think that combining the scholarly side and industrial side by providing exhibits at the same time as public lectures is a very good plan.

Broad Utilization of Biotechnology

Suzuki: Well, moving on to our main topic, I would like to exchange views concerning the present status and future prospects for bioindustry in Japan and America. First I shall ask Chairman Arima to explain the special features of Japanese biotechnology.

Arima: In the fermentation industry field Japan has a history of having made such things as soybean paste [miso] and soy sauce. But it was after World War II that we made rapid progress due to the cooperation and guidance of Americans in such things as penicillin. At present I suspect we could be said to be leading the world in regard to fermentation industry.

Moreover, in the new biotechnology, too, which appeared 10 years ago, at first it appeared as though we might be behind Europe and America, but enterprises and administration and academic circles related to pharmaceuticals, chemistry and fermentation made strong efforts to introduce the new biotechnology, so I think it has now been possible to catch up for the most part. Of course, at the present point in time, throughout the world, including Japan, there has been no progress in turning it into commercial products, but....

However, according to "The Impact Exerted by Biotechnology on Industrial Structure in the Year 2000" which our Bioindustry Promotion Operation Division surveyed in August 1985, it is estimated that the scale of production based on biotechnology will be 15 trillion yen, and will generate added value of 6.3 trillion yen.

In any case, I think that now is an extremely important time in which we are standing on the starting line of industrialization of biotechnology.

Young: I certainly think so too.

Suzuki: At MITI as well, I will touch upon this later, but judging from the fact that we published something called "Guidelines for Industrialization of DNA Rearrangement Technology" in June 1985, I think that industrialization using DNA rearrangement technology will begin some time in the current fiscal year. Since it is the year in which industrialization will begin, we are calling FY86 "the first year of the era of practical development of bioindustry," and are speculating that after this it will go on developing to a new stage. Accompanying that, MITI's policy toward biotechnology, will also probably have to go on developing measures from those up to now, which have been centered on development of technology, to ones for the stage of industrialization.

Well then, next I would like to ask Director Young for his opinion concerning the present status and future prospects for U.S. biotechnology or bioindustry.

Young: I will begin with the present status; America too, in the same manner as Japan, has just entered industrialization and has come to a period of making great strides.

The technique of rearrangement of genes was discovered by doctors (Cohn) and (Boyer) in 1973, and in the 13 years from that time to the present consciousness has awakened on what its possibility is in regard to industrial utilization of biotechnology, so it has been researched in various ways. Now we have finally reached the point of being able to gain great confidence regarding this possibility.

Suzuki: What are the exact fields...?

Young: To begin with, even within the field of medicine, there is great expectation of growth in pharmaceuticals. For example there is human growth hormone; the technique of DNA rearrangement has contributed greatly to this. It is the point of removing genes and using them to create human growth hormone inside bacteria. Up to now human growth hormone has been extracted from the human pituitary gland, but [now] it is created and grown inside bacteria, so it is much much less expensive.

In addition to its growth function, this growth hormone is very effective in healing wounds, and, as a possibility, it will be useful in forming bone structure and will maintain bones--it will probably become possible to retain strong bones for a long time even if one becomes old.

Furthermore, among items for which there is hope as specific medicines against cancer, there is alpha interferon; through progress in biotechnology, the point has been reached where today this too can be made by using bacteria or yeast fungi.

And another field in which it can make a great contribution is the production of vaccines. Particularly in Africa and so on there are very many kinds of disease, and each year many people fall victim because there is no vaccine. With this too, many people will be saved if it becomes possible to produce large volumes of vaccine by an easy method.

Arima: There are also important fields beside pharmaceuticals, right?

Young: Yes, there are. It is useful in treatment of drainage water; this is a very important field. There is Minamata disease, which has now become a global problem, and similar pollution from industrial drainage, and I suspect that it will be possible to solve this, too, by using a bioreactor which is an advanced technology.

There is hope that by application of this technology it will be possible to also eradicate the highly toxic heavy metal material contained in drainage water, which was the cause of Minamata disease.

Moreover, there are high hopes in the energy field as well. After all, the shortage of combustible energy is a problem that leads to headaches everywhere. The method is a matter of production of substitute energy such as methane and hydrogen by application of the photosynthesis function possessed by plants and use of the technique of DNA rearrangement, but it will probably require a bit more time.

And one more thing, for a familiar field there is food production. In this field, such things as creation of good quality or increased production by improvement of species through application of biotechnology have now become generally known. But in addition to that, I suspect that DNA rearrangement technology in particular will be able to contribute greatly in very bad environments, even under such bad conditions as, for example, water being muddy or soil being polluted.

Arima: Even in addition to that, the bioelectronics area is also hopeful, is it not. In regard to biosensors we have already entered the stage of practical development, and research on bioelements will also probably become more earnest in the future. Biocomputers, too,...there are some people who say they are an empty dream, but they may be realized fairly quickly.

Suzuki: In regard to bioelements, beginning in 1986 they were taken up as a theme by the R & D System For Next Generation Industries, so future research and development is anticipated. The fact that there are hopes for biotechnology in many areas in this way is probably a matter of the range of its application being so wide.

Well then, next I think I would like to ask you about cooperation of industry, academia and government, which is very important in promoting technological development.

Leading by Guidelines Rather Than Regulations

Arima: Earlier I said that in regard to new biotechnology Japan had more or less caught up with Europe and America, but when it comes to the future next generation of biotechnology, Japan not only has a smaller number of researchers than America, but its government also provides less research funds, so, with things as they are, I think that great growth cannot be anticipated for Japan in the future.

Therefore, for Japan, it is probably important to accurately ascertain the new technology which it is thought will support the next generation, and to go on promoting in a concentrated manner the development of that technology and the training of persons talented in that technology under close cooperation of industry, academia and government.

Young: Yes, and what is important at the same time, is that, first of all, as the role of "academia," of course there is research and development and the training of persons of talent, but I think that along with that its function also lies in evaluating the safety of specific materials and products and in making this evaluation public.

Next, as to the role of "industry," it is probably important for industry to take responsibility for the safety of goods produced and to provide the people of the nation with high-quality goods.

Finally, as the most important role of "government," I think it lies in striving, when determining policy, to build a consensus by listening well to the opinions of research specialists and the opinions of every strata of the

population. In other words, I think that industry, academia and government form the base for development of biotechnology like the three legs of a tripod, so cooperation of the three groups is indispensable.

Suzuki: Cooperation among industry, academia and government is very important both in Japan and America. Next is the problem of safety, which also appeared in what Director Young said just now. In regard to this, I will begin by stating some of the details.

Even within biotechnology, in DNA rearrangement technology in particular there is concern that unknown and potentially dangerous organisms might be created, so guidelines have already been formulated at the experimental stage. After that, since there was not so much danger, the guidelines at the experimental stage have also begun to be relaxed, but one cannot say positively that it is completely safe. Therefore, since the industrialization stage is right before our eyes, in the OECD beginning in 1984 the work of formulation of guidelines for the industrialization stage was advanced by representatives of each country, and in July 1985 they passed the approval of the Board of Directors and were published.

At MITI too, we advanced the work of formulating guidelines parallel to this, and published "Guidelines for Industrialization of DNA Rearrangement Technology" in June 1985. The most important feature of these guidelines is the fact that we newly introduced the concept of GLISP [expansion unknown] (superior industrial manufacturing model). It means that one may manufacture by ordinary equipment and apparatus if one uses very safe rearrangement microorganisms. Of course it is important to guarantee safety, but this was done in order to avoid impeding the development of the bioindustry by excessive regulation.

Young: In the case of America, the first principle in regard to guaranteeing safety is that it is important that it be safe when viewed scientifically. But it is much more dangerous to view it as dangerous just by imagination and speculation. Therefore, it is a matter of investigating it thoroughly based upon a scientific viewpoint--a matter of determining safety based upon a risk assessment by scientists.

The second is placing emphasis on the finished product itself. By that I mean that at present a biotechnology revolution has occurred, and new technologies are being developed rapidly in order to create a certain product. If the regulations are directed toward technology, one will have to constantly revise and assess the regulations, so it will become very troublesome.

The third is to be flexible toward regulation. This is because if one goes and binds up things to much by law, contrary to what one might expect, it could easily become an encumbrance on development, so....

The above is the basic view of the United States, and particularly of the FDA, regarding safety.

Suzuki: Director Young, we too agree with the point which you voiced of adopting a flexible attitude toward regulation. Due to the fact that at

present the potential danger of DNA rearrangement technology is still in the realm of conjecture, and the fact that development of technology in this field is making rapid progress and it is thought that knowledge concerning safety will also go on increasing in the future, we think that an administrative-guidance type method based on guidelines is more appropriate than regulation by laws.

Safety is a very sensitive question, so, in the future as well, it is probably important to go on advancing policy while keeping in close contact internationally.

In addition, I had also wanted to ask both of you for your opinions concerning such international cooperation in research as the Human Frontier Science Program, but we have run out of time, so I would like end at this point. Thank you very much.

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RESEARCH ON TITANIUM ALLOY BATHYVESSEL OUTLINED

Tokyo FUNE NO KAGAKU in Japanese Oct 86, pp 48 - 49

[Article by N. Endo, T. Yokota, et al.]

[Text] 1. Introduction

We have been conducting research on a titanium alloy (Ti-6Al-4VELI) material for use in the pressure-resistant shell of the 6000-meter class underwater vessel now being planned in the next Japanese deep-diving survey vessel project to follow "Shinkai 2000." Our research covers both materials and fabrication techniques.

6Al-4VELI titanium alloy was used in a small pressure-resistant vessel in the Shinkai 2000 project, but the use of this material in a pressure-resistant shell would involve the largest structure in which 6Al-4V titanium alloy has ever been used in Japan, so investigation and research on both materials and machining is necessary. The authors constructed a full-size model, which resulted in our successfully perfecting a super-thick titanium alloy plate manufacturing method, a hemisphere hot-molding method, heat treatments, electron beam welding techniques, and three-dimensional machining techniques.

We also dismantled the full-scale model and studied the material properties and residual stress in each part thereof, thereby verifying that a titanium alloy spherical shell fabricated by methods based on this research satisfies the performance demands for a deep-underwater survey vessel's pressure-resistant shell, and gaining a clear prospect for the practical implementation of a titanium alloy pressure-resistant spherical shell.

The actual-size model simulates the pressure-resistant shell of an actual device having an inner diameter of 2 meters and a final plate thickness of 70 mm. 6Al-4V titanium alloy was used in the hemisphere (N hemisphere) and equatorial ring (equatorial joining member), while industrial-purity titanium was used in the hemisphere (S hemisphere) excluding the equatorial joining member. The N hemisphere was provided with two observation-window through-hole hardware units (500 mm in diameter), one electrical-wire through-hole hardware unit (800 mm in diameter), and one hatch opening (500 mm in diameter).

(1) Manufacture of Materials

The rolled plate for the N hemisphere was manufactured by using vacuum melting and forging a 9-ton ingot to a material thickness of 115 mm, and rolling this. The material for the equatorial ring and the through-hole hardware units was forged from a 5-ton ingot, and subjected to solution overtime annealing (STOA) processing. The Electrical-wire through-hole hardware unit was rendered into the desired shape by hot molding.

(2) Manufacture of Hemisphere Shell Material

The rolled plate was formed by integral heat molding with an 8000-ton press, and then subjected to STOA processing to manufacture the hemisphere shell material. The shape after heat molding was such that the inner radius was 968 - 994 mm and the plate thickness 105 - 140 mm, which was adequate to cut out a hemisphere shell having an inner diameter of 2 meters and a plate thickness of 70 mm. The material performance was verified with test pieces taken from the excess length of the equatorial member, and found to fully satisfy the standards (AMS 4907C).

(3) Welding Through-Hole Hardware Units Into Place

After performing rough machining on the N hemisphere, holes were made for the through-hole hardware units and the said units were welded into place with electron-beam welding. A 45-kW electron-beam welding unit was used, and the welding was done in a downward-directed attitude while rotating the hemisphere. At this time, test plate was welded under the same conditions to verify the joining performance. Good results were obtained in which the welding strength adequately matched the tensile strength of the parent material. After the welding was completed, we performed post-welding heat treatments to release residual stress.

(4) Fine Machining on Hemispheres

Fine machining processing was performed on the inner and outer surfaces, excluding the equatorial portion, by means of a three-dimensional machining technique. By means of this technique, machining was performed after the through-hole hardware welding. This enabled us to prevent distortion from remaining from the welding operation, and to fabricate hemispheres that were nearly perfectly spherical.

(5) Equatorial Welding, Final Finishing Work

The N hemisphere and the S hemisphere with the equatorial ring attached were joined by electron-beam welding. The equatorial welding was done in a horizontally oriented posture while rotating the spherical shell. The equatorial welding was also subjected to verification tests using test plate, and it was confirmed that the welding strength matched the tensile strength of the parent material. After completing the equatorial welding,

we performed post-welding heat treatment and did the final finishing work on the equatorial member.

(6) Shape Measurements, Non-Destructive Tests on Welds

RT (radiographic testing), UT (ultrasonic testing), and PT (penetrant testing) was conducted on the welded joints. The through-hole hardware fitting joints all passed the PT and RT, and both surface soundness and internal soundness was confirmed. Moreover, the sphericity was found to be within 1.003 in the final shape measurements, which, compared to the 1.062 for the Shinkai 2000, indicates that an extremely good shape was obtained.

3. Dismantling Tests

We dismantled the full-size model which we had made, took samples from the N hemisphere parent material, the through-hole hardware units, the equatorial welding joints, and the through-hole welding joints, and conducted evaluation tests. The main results of these tests are set forth below.

(1) Tensile Characteristics

We took test pieces from the N hemisphere and the through-hole hardware and examined the tensile strengths. The results of these tests showed that there was little difference in tensile strength with different sampling directions or sampling locations, and the standards were satisfied in all cases. There was also little difference between the sampling locations and between the beginning and ending edges of the welds in samples taken from the welding metal, and the tensile strengths tended to be slightly greater than they were in the parent material (95 - 99 kgf/sq mm). The elongation tended to be slightly lower (9 - 14 percent) than in the parent material, but thoroughly satisfied the 5 percent value specified for Shinkai 2000. It was demonstrated in joint pulling tests that the welded joints had greater tensile strength than the parent material. These results confirmed that both the parent material and the welded joints had good tensile strength.

(2) Toughness

Ti-6Al-4VELI alloy exhibits no transition phenomenon at low temperatures as does steel material, so Charpy impact tests were conducted for reference information, even though there are no particular provisions for this in the AMS or other standards. The test results showed little difference depending on where or in what direction the samples were taken. With respect to the welds, there was a very slight decline in Charpy absorption energy from HAZ to bond to weld metal.

The DT characteristics tended to be roughly the same for both parent material and welded joints, and when compared to the RAD diagram, was confirmed to be in the region of plastic destruction and not in the region of brittle destruction.

(3) Stress Corrosion Crack Susceptibility

The Kiscc value for the stress corrosion crack susceptibility for the parent material and the weld metal was around $160 \text{ kgf/mm}^{3/2}$. With a Kiscc of $150 \text{ kgf/mm}^{3/2}$ and assuming we have a pull-action stress of 1/10 σ_{max} from the residual stress distribution, the allowed flaw dimension is 530 mm, which is a dimension that can be adequately detected in non-destructive tests.

(4) Low-Cycle Fatigue Characteristics

There is almost no change in the low-cycle fatigue strength moving from the atmosphere to a 3.5-percent NaCl aqueous solution, and almost no difference between the parent material and the welded joints. When the maximum compression stress was made 75 percent with 0.2-percent proof-stress (0.53 percent with the compression distortion), the crack-occurrence total-distortion range was 1.75 percent, showing that it was on the safe side of the design value (0.53 percent).

(5) Macrostructures, Microstructures

The macrostructures for both the parent material and the welded joints were sound structures having no flaws. The microstructure of the parent material was a mixed structure of isometric alpha and modified beta, while the microstructure of the welded metal was a needle-form alpha structure, with no particular abnormalities found.

(6) Residual Stress Distribution

We measured the residual stresses in the equatorial joint and the fitted joints. We found that almost all of the residual stress was released by the post-welding treatment, to less than 3 kgf/mm^2 .

4. Concluding Remarks

We conducted research on using a pressure-resistant shell made of 6Al-4V titanium alloy for the deep-diving survey vessel project which is a follow-up to Shinkai 2000 and obtained the results noted below.

(1) We were able to perfect manufacturing techniques for super-thick titanium-alloy plate, manufacturing techniques for making hemispherical shells by heat molding, heat-treating techniques, three-dimensional machining techniques, electron-beam welding techniques, and non-destructive testing techniques, and to fabricate a full-size model of a pressure-resistant shell made of 6Al-4VELI titanium alloy having a sphericity of 1.003, which is nearly perfectly spherical.

(2) We examined the material properties of and the residual stress distribution in the parent material and welds, by means of dismantling tests on the full-size model. The quantitative results were all favorable,

demonstrating that the pressure-resistant shell for the deep-diving survey vessel satisfies the desired performance parameters.

Based on these results, we believe that the application of titanium alloys in pressure-resistant shells for deep-diving survey vessels is feasible.

We wish to express our deep appreciation to Y. Yamamoto, professor emeritus at Tokyo University, to K. Sato, professor at Osaka University, and to K. Kimura, professor at Kogakuin University, for their guidance in this research.

(N. Endo is at Tokai University, T. Yokots and three other authors are with Mitsubishi Heavy Industries, Ltd, and two other authors are with Kobe Steel, Ltd.)

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CSO: 4306/7011

NEW MATERIALS

STRATEGIES OF NONFERROUS-METALS CORPORATIONS DISCUSSED

Sumitomo Metal Mining Corp.

Tokyo KINZOKU JIHO in Japanese 5 Jun 86 pp 196-198

[Interview with Masaaki Ueda, an executive director of Sumitomo Metal Mining Corp.; interviewer, date, and place not specified]

[Text] [Question] The attitude of Sumitomo Metal Mining in pursuing electronic materials and new raw materials is so intensive and extensive that it is beyond comparison to other nonferrous metal corporations. For this reason, the goal of the other corporations seems to be to catch up with Sumitomo Metal. Would you tell me about, among other things, the effect of the recent high yen?

[Answer] The high yen is directly hurting the nonferrous metal sector. Our corporation, nevertheless, began pursuing new raw materials and electronic materials in around 1958. As a metal mining corporation, Sumitomo Metal Mining then had 70 to 80 percent of its 8,000 employees engaged in mining and other related work, with the remainder working in the refining sector. The mining sector, has been declining rapidly, since then, leaving only about 200 workers, at Hishikari (mine) still remaining.

Efforts to create new jobs to be given to the company's 8,000 workers induced this corporation to take steps toward electronic materials. The corporation began by recycling scrapped Ge offered by NEC Corp. The corporation has continued to work on the development of raw materials, mainly on the basis of the requirements of the NEC Corp., but has also been favored in various aspects by other electrical appliance corporations in the course of its expansion.

Our new raw materials and related sectors, fall into three categories. There is the category of electronic materials which began, as mentioned above, with recycling of scrapped Ge. The corporation then undertook the manufacture of solder alloys, Au Si alloys and other metals utilizing its own metal technologies. Subsequently, the development of lead frame materials of Cu series, 42 alloy series and others followed. An integrated system of manufacturing lead frames from raw materials to the end product has been established. The process involves, among other things, rolling the plate material, stamping the rolled material with dies and electroplating the stamped material. The manufacture of bonding wires of Au and Al-Si has also been undertaken.

In addition, the corporation has been working on single crystal materials and has developed such single crystals as GaP, GaAs, LN, LT, GGG, YAG, and YSAG (Gd·Sc·Al·garnet), with the capacity for production and supply of GaP being the largest in the world; currently, however, the major emphasis is being placed on crystals related to optoelectronics.

A second major category in which the corporation has long engaged itself, involves the refining of nonferrous metals. One could not expect the sales of such raw materials as Cu, Ni, Pb, and Zn to grow, if not processed some way or another. The corporation has, therefore, endeavored to create new functions for these materials by such means as producing superfine powder, special alloys, or oxidized Sb and Pb of low α ray. The corporation, for example, has engaged in the development of Ni and Cu of a type that can be used for gilding without the application of electrolysis; these can be added to the conventional electroplating materials of copper sulfate, nickel sulfate, and nickel chloride which have long been manufactured. The corporation is charging ahead with the development of something of a new function such as the above which must brace up the nonferrous metal sector.

The materials of the third category, which do not belong to the above two electronic and nonferrous materials categories, are those of the more distant future and are being developed largely by the Central Research Institute. Some examples are photomagnetic recording materials and materials for surface modification using PVD, CVD, and ionic injection.

Emphasis is placed on new raw materials in the above three categories as the corporation proceeds with its R&D, to which ¥6 billion is allotted annually. The allotment grew steeply at annual rates of 20 to 30 percent for the last 3 or 4 years. It will remain at ¥6 billion this year, the same as last year, however, due to the recent high yen and the consequent stringent economy. Eighty percent of the relevant cost is allotted to the above three categories with the remaining 20 percent being used for the research of construction and metal materials.

Combined Effects of the Central Research Institute, the Niihama Research Institute, and the Electronic Material Research Institute Being Displayed

[Question] How is the R&D system organized? Does a headquarters for R&D dictate all subordinate organs and relevant affairs?

[Answer] Research is expedited by three research institutes, namely, the Central, the Niihama, and the Electronic Materials Research Institutes with the Construction Material Research Department and a test center for metal materials doing additional research work. The Central Research Institute, which is a direct subordinate of the Headquarters for Research and Development and made up of 200 workers, undertakes the problems of the comparatively distant future. The Niihama Research Institute, with 100 workers, belongs to the Metallurgy Division and engages in the research of the dressing and smelting of ores. And last, the Electronic Material Research Institute, with 100 workers, is subordinate to the Electronic Metal Division and is responsible for, as the name indicates, research on electronic materials in general.

The research and development activities of the corporation are more decision making and disposal of problems to subordinate rank rather than a type of stringent control by central management. Each research institute pursues its own research problems, displaying its individuality. Only for the purpose of preventing dismembering of research does the Headquarters for Research and Development provide overall supervision. The intention is not to control but to coordinate, by means of, say, the warp and woof passed through each.

[Question] What do you think is the part played by the New Raw Materials and Electronic Materials Divisions in the corporation as a whole? I suppose that expanding electronic materials into a major work division for this corporation has long been a suggested target.

[Answer] Electronic materials seem to have a rather long way to go before it really becomes one of the major sectors of this corporation. In terms of both the amount of sales and the number of workers employed, the conventional raw materials division constitutes an overwhelming share in that area, whereas new raw materials, which includes electronic materials, has only a limited share. Nevertheless, the president of the corporation has suggested that the share of new raw materials be increased by up to 50 percent, in terms of profits, in relation to the conventional raw materials of Cu, Pb, Ni, and Zn. The goal which is to be reached by the business year 1988, is in reality a difficult one indeed.

[Question] I think that because of its excellent fundamentals, the corporation can set a goal of 50 percent profit for the new raw materials sector. When other corporations failed in, and gave up on germanium, the Sumitomo metal Mining Corp. dared to pursue other electronic materials. This history of the Sumitomo Metal Mining Corp. has, I suppose, contributed much to building the solid basis of the corporation.

[Answer] Developmental work on electronic materials is time-consuming and requires lasting and enduring efforts. Any corporation venturing into electronic materials has to possess technology of its own for the assessment of the material in the first place. When the manufacturer subsequently offers a product to users, the users, in turn, take their time in assessment and considerable time has to elapse before any conclusion can be reached. Once users accept the material, nevertheless, they are not in a position to arbitrary change materials and must adhere to it for a long time. Anyway, work built up over long periods of time is imperative for new raw materials as opposed to old materials which are dictated by momentary decisions.

Promoting the Development of Rare-Earth Elements Which Offer the Prospect of High Gains Both Upstream and Downstream of Manufacturing

[Question] The corporation has recently announced the establishment, jointly with Rohne Poulenc, of a corporation for the manufacture and sale of metals of the rare earth group. Would you tell me the objective?

With nonferrous metals having no prospect of growth as raw materials, the corporation has been looking for new substances which it could work on as raw materials. The rare earth metals, which anyone can conceive of as a target, nevertheless, do not make a paying business unless the entire 17 elements involved can find a market soon--they are referred to as balance merchandise for this reason. Though initially intending to commercialize these elements on its own, the corporation decided later not to venture independently and looked for a partner. The corporation, at this juncture, started negotiation with Rohne Poulenc Corp., which, along with the Moricorp Corp., represents the major relevant corporations in the world, and from which the corporation has been importing samarium oxide for 10 or so years. Rohne Poulenc, in turn, seems to have intended to consolidate its foothold in Japan, a big market for the rare-earth elements, and, hence, to set up a joint effort with a Japanese corporation, since firms of exclusively foreign capital have only limited capabilities here. After evaluating various aspects of many corporations, Rohne Poulenc picked, perhaps, a corporation which possesses a knowledge of the relevant resources and also of areas demanding electronic materials, that is, a corporation which has knowledge of both the upstream and downstream industries of the manufacture of these elements. The Sumitomo Metal Mining Corp. was its choice.

with Japan using the products of rare-earth elements in substantial amounts, the first and foremost demand from the user is the stability of supply. For this reason, the union of this corporation and Rohne Poulenc should afford the user a feeling of great security.

[Question] With the three major enterprises, Mitsui Mining and Smelting, Mitsubishi Chemical Industry, and Sumitomo Metal Mining each fighting for its share of the market of the rare-earth metals, Sumitomo Metal Mining perhaps got a good bargain since the corporation imported \$5.1 billion worth of rare-earth element products from Rohne Poulenc last year. What do you think Rohne Poulenc is expecting from its partner in exchange? Does the bargain mean another foothold in China for Rohne Poulenc?

[Answer] The question is, what about the corporation sparked interest in Rohne Poulenc, say, an interview marriage. I presume one point is that Sumitomo Metal Mining has experience in the development of relevant resources and another is that it has built up a knowledge of the needs and other information about the downstream industry. The question concerning China has not been raised particularly; the Rohne Poulenc neither highly estimates its partner for copper smelting in Chiangshi Province nor has substantial concern in the rare-earth element resources in China. Rohne Poulenc seems to have no worry over the supply of raw materials since it has raw materials supplied largely from Australia and, besides, has recently acquired a mine in the United States.

[Question] The timing of the entry into the market is excellent, I suppose, since magnets of the Nd-Fe-B series are just finding new markets. May I ask, in connection with this, whether the time for the start of production and the site of the plant has already been planned?

[Answer] Much is expected of magnets of the Nd series. However, the question of when, where, and what material to manufacture has not yet been settled at all. The work will open tentatively by taking over the sales business of Rohne Poulenc Japan, Ltd.

[Question] Cobalt, which is indispensable for Sm-Co magnets, is also of major importance as a magnetic material. What do you think is the prospect of the cobalt industry?

[Answer] Cobalt should have a promising future. The political condition of Zaire, the major supplier of the ore, has not been stable, however, and once culminated in an upheaval. The possibility of exploiting cheap manganese masses occurring on the bottom of the Pacific, which is not deniable and could eliminate cobalt from the list of rare metals, will not become a reality before the year 2000. Cobalt is, therefore, a valuable metal, at least for the time being. Smelting of cobalt by Sumitomo Metal Mining at Niihama involves technologies which are superior in terms of the quality of the metal, but not satisfactory in terms of price. The question of how to reduce the cost poses a major problem and makes for an important goal for R&D. The corporation is working on this problem and hoping to achieve the lowest smelting cost in the world.

Importance of Research for Creating Functional Materials From Old Metals

[Question] What do you think is the possibility of new applications for the old metals such as Cu, Pb, and Zn?

[Answer] That question is the main subject of research at the Niihama Research Institute. One-half of the R&D of the institute is directed toward dressing and smelting ores wherein emphasis is placed on cost reduction. The other half is directed towards creating materials with new functions from the old raw materials. In the case of Zn, for example, a blended zinc is a zinc product involving addition of various other compounds and is used for gilding, by dipping, of iron plates with zinc. Steel plate gilded with zinc for automobiles, in turn, is growing in sales splendidly, and has been adopted in all automobiles for export. This metal abhors rusting and consumes large quantities of zinc in the carbonate form. Furthermore, gilding of iron plates with a Zn Ni alloy involving small quantities of nickel has been spotlighted because of its increased resistance to corrosion.

Nickel has a promising future in antiheat and anticorrosion superalloys as represented by Ni Co alloys, in addition to the above application in gilding of iron plates of automobiles.

[Question] The corporation has recently embarked on the manufacture of silver oxide for small electronic cells. Is the manufacture going smoothly?

[Answer] The corporation has been marketing argentous (silver I) oxide and argentic (silver II) oxide. With falling prices of watches, the argentous oxide used in watches has grown relatively expensive, however, and recent products shipped, hence, have manganese dioxide cores covered with argentous

oxide, thereby saving silver. The user seems to favor the low prices, though it may have a shorter life.

[Question] In connection with electronic raw materials, the corporation seems to be actively engaging in overseas ventures as well, as seen in the construction of a plant in the United States following one in Singapore. What is your overseas strategy for the coming years?

The basic idea for the manufacture of electronic materials is to produce them at the very site of any large market. A plant, I believe, should be built at the site overseas where demands exist rather than exporting products to there. Besides, other nations have recovered from last year's business slumps before our country. The Singapore plant, which engages in gilding, has been recovered since last summer and the U.S. plant for photoetching and gilding made a turnaround last October.

A new plant for the manufacture of gold wires for bonding, however, was constructed at Oguchidenshi, Kagoshima Prefecture; since the bending wire is not bulky, it can be easily transported.

First Emergency Countermeasure Against the High Yen Is Cuts in Electric Charges to the Overseas Levels

[Question] Finally one sees all nonferrous metal makers in turmoil because of the high yen. Do you think there is any instant remedy for this?

[Answer] I do not think there is any instant remedy for the nonferrous metal industry. Among the conceivable countermeasures, I suggest that electricity cost be brought down to the levels of other nations in the first place. With electricity costs being around ¥5 to 6 per watt in Europe and ¥2 to 3 per watt in the United States, the cost in Japan should be brought down at least to the level of Europe, if not to that of the United States. The nonferrous metal industry cannot survive by any means except by the above reduction in the cost of electricity and by a reduction in costs at the actual plant workshops. Cuts in cost at the workshop imply lower commodity costs and high productivity. It is also hoped that the freight rate for raw material ores will be lowered since cheaper oils are used, and that, since every corporation is under the burden of heavy debts, interests on debts be lowered immediately following a cut in the official discount rate.

Our corporation's motto is 3S, for speed, straight, and simple, which the employee reverently recites everyday. It is hoped that the return to the public of windfall profits from the high yen and the lowering of interest rates, among other things, will be made with dispatch.

Kawasaki Steel Corp.

Tokyo KINZOKU JIHO in Japanese 25 Jul 86 pp 222-224

[Interview with Taku Osukegawa, chief of the Planning and Coordination Division of the Chemical Enterprise Department; interviewer, date, and place not specified]

[Text] [Question] One sees Kawasaki Steel actively expanding its undertakings into the electronic industry as exemplified by production of masterslice gate arrays by means of a joint venture with the U.S. semiconductor maker LSI Logic Corp., and by production of ferrite magnets by means of a joint venture with Pesiney of France, as well as by production of semiconductor silicon. Do you supervise, in general, those activities for the corporation's electronic materials.

[Answer] The Chemical Enterprise Department is responsible for the manufacture of silicon wafers but manufacturing of other electronic materials, such as magnets, belongs to other departments. Our department deals largely with the byproducts of coal and cokes ranging from benzene to pitch. Additionally, we produce iron oxide by chemically treating iron chloride which results from washing hot coils with acid at ironworks. We also embarked recently on the sale of gases. Therefore, we are in charge of largely three sectors, coal tar products, iron oxide, and gases, with chemical technologies as the major basis for expansion. The electronic materials we have manufactured so far, in turn, have been comprised merely of roasted powder, largely of iron oxide, for use in magnets, with semiconductor silicon added recently.

Objections were raised in connection with the assignment of the silicon enterprise to the Chemical Enterprise Department but we finally reached the conclusion that, of the only three departments, steel, engineering, and chemical, there is no choice but the last for silicon manufacturing. As we see it, starters in the silicon industry are mostly chemical corporations such as Volker Chemicals, Monsant Chemicals, and Shinetsu Chemicals.

[Question] In connection with the silicon enterprise, Kawasaki Steel seems to plan doubling the production (2 million sheets, per year) of the NBK Corp. (of the United States), which Kawasaki Steel bought last August. Would you tell me the plan for that expansion?

[Answer] Whether an expansion of the production of silicon wafers should be made in the United States or a new plant be constructed in Japan in the future has been a major question. In view of the recent moves of the exchange rate of the year, however, we favor expanding production first in the United States and, with some surplus spaces available at the NBK plants, decided to do so because it is more economical.

The production will be increased to an annual sales of \$20 million to \$30 million within the 1986 business year. This is the tentative target and, in connection with this, improvement of technologies of the NBK Corp. and of the quality of the product was the major problem posed in the first place.

Technology of NBK Assessed Highly and Replacement of Old Facilities by Most Advanced Underway

[Question] Would you tell me your frank impression of the NBK Corp. which Kawasaki Steel has finally obtained?

[Answer] Its technologies for crystal must be assessed fairly high. Though the production equipment is old, NBK Corp. devised technologies of its own. The technology for oxygen control, etc., has been favored substantially on the U.S. market.

Nevertheless, I felt that downstream processing was the bottleneck of the plant because of its very old equipment. Automation related equipment is also not up to date. Replacement of facilities for downstream processing is now underway.

I found also that the middle supervisory management zone, i.e., staff between the executives and the common employees, is not sufficiently powerful, which, I suppose, is a common feature of U.S. corporations. Our corporation is sending employees from Japan to fill this gap. It was also noted that the American, as opposed to the Japanese, is highly individualistic and lacks coordination among the sectors of the corporation; control by the management, hence, has been sometimes necessary.

In connection with the sales of the product, I found the quality of the wafers, though evaluated fairly high on the U.S. market, was inferior to the quality of products produced in Japan. This small-scale production was also a drawback.

[Question] May I ask the reason why Kawasaki Steel resorted to the purchase of an overseas enterprise instead of finding a business partner in Japan.

[Answer] I suppose because finding a partner in Japan involves utmost difficulty. I have to answer simply that we were unable to find any possibility for such a union.

The decision must conceivably have been based on the inference, as commented once by the executive director of our corporation, Kato, that if we start from zero, the venture will take a long time, we are not assured of technological success therein, and finding a channel to the market is arduous work and it would presumably be faster and safer, instead, to buy one whole plant, as it goes on operation, with its present technologies, technologists, and channels to the market included.

This does not mean that our decision to buy NBK Corp. was rash. Though we made no contact with Japanese elementary device firms, we selected several firms, including Celtechs in the United States, evaluated them, and compared them with each other before we finally picked up NBK Corp.

Investment of \$10 Million Including Purchase Price, Cost of New Facilities

[Question] How much cheaper do you think the purchase of NBK Corp. was than the construction of a new plant at a new site wherein you start from zero and prepare everything? Again, how much do you plan to invest in order to establish a tentative system with an annual sales of \$20 billion?

[Answer] I suppose, the cost for the purchase of the plant must be less than one-half the cost of the construction of a new plant at a new site. It is a fairly profitable bargain. The fact that it has saved time, compared with starting at zero, is, in particular, the biggest advantage, though it cannot be assessed in money. I suppose improvement of and increasing production in the NBK plants will take some \$10 million over and above the purchase price. [as published]

[Question] Since every Japanese silicon maker plans to embark on production in the United States, Kawasaki Steel, conceivably, has the advantage of having obtained a foothold there earlier than the others. In connection with this, what do you think is the prospective growth of the silicon industry in the United States?

[Answer] Though NBK is not a big company and hence has not had a large share in the U.S. market, it has been highly reputed in such specific areas as discrete products by a substantially large number of customers. The name of the corporation, on that and other accounts, is correspondingly familiar to the user which, I believe, should provide an advantage in the future expansion of the enterprise. Their technologies and the quality of their products are generally regarded as behind those of Japan, but they must be improved in the future and their market, hence, will grow at a rate similar to that of Japan, allowing for the trade friction problem. We are not overly pessimistic about the present handicap of NBK; we have the prospect of success in this undertaking providing channels to users in Japan are obtained in addition to current sales routes.

Supply of Products to LSI Logic, Establishment of High Quality Products Preceding Activities in Japan

[Question] Would you tell me the diameter in inches of the wafers currently most commonly produced? Would you also tell me when you expect to ship samples to Japan?

[Answer] The most common wafers are currently 4 inches in diameter but 5-inch wafers are replacing the 4-inch ones as the major product and 6-inch wafers have begun to be produced, though in limited quantities. Even though 7-inch wafers have already been trial manufactured, the market, including that of Japan, I think, in reality seems to be beginning to change to 6-inch wafers.

The product will be imported into Japan after it has been improved in quality. We tentatively plan, as our first goal, to supply 6-inch wafers to LSI Logic and thereby establish qualities of products satisfactory to LSI Logic. Since LSI Logic has to compete with the most powerful of the Japanese elementary

device makers, products satisfactory to that corporation will be accepted by the Japanese users without a handicap. The product may conceivably be supplied to Japan Semiconductor, a joint venture with LSI Logic, but it would not make much sense anyway to scatter samples among Japanese users at this juncture.

Research on 8-Inch Wafers, MCZ, etc., Underway at the High Technology Research Institute

[Question] With the scale of silicon production presently in plan, you seem not to have to look for customers intensively, do you, since LSI Logic accepts your products and, as it stands, Japan Semiconductor may also be your customer?

[Answer] Our venture in silicon is not, of course, limited to the present scale. Customers will not take our venture seriously if no future expansion of the venture can be expected. Nevertheless, the expansion of this venture must be made in an orderly manner; we are not in a position to boast a big plan; we must proceed steadfastly and, hence, place emphasis on raising quality.

For sales of silicon products in Japan, something of a technical center or service center may perhaps be necessary which must be made full fledged and be assigned the function of delivering the products. Where technological research is concerned, we plan to make the utmost of the High Technology Research Institute of Kawasaki Steel. We are engaged in research in a manner different from Sony Corp., on MCZ and on the manufacture of 8-inch wafers.

[Question] After you have set up a system for an annual sales of \$20 million for NBK, do you plan to expand the production in the United States or do you plan to construct a new plant in Japan as the next step?

[Answer] We plan to construct a new plant in Japan also. However, it is imperative, as a tentative target, to raise our level of processing technology to that of Japan. Subsequently, we will decide whether we expand the present U.S. plant or to construct a new plant in Japan. Anyway, processing of wafers is a work suitable to Japanese, I suppose, as is processing of elementary devices. These are processes which can be performed by the sensitive nerve of the Japanese, in particular, dictating all of the operations along the line of production. In that sense, production in Japan may be favored. Anyway, the decision will have to be made allowing for the fluctuation of both the U.S. and Japanese markets.

[Question] It was reported that the number of employees of NBK was increasing from the current 40-odd to over 100. In connection with this, what policy do you hold for maintaining the required numbers of technologists and for improving technologies?

[Answer] I cannot understand why such an estimate on the number of employees was made, but I suppose that the number 40 may indicate that of white-collar workers of technological expertise. The number of technologists, anyway, is

far from satisfactory yet. They will be looked for and recruited whether they are Japanese or foreigners. Improvement of existing technologies and development of new technologies will be pursued with the High Technology Research Institute also playing a dominant role.

[Question] It seems that price competition is unavoidable in the sale of silicon. Would you tell me your viewpoint on this problem? Would you also tell me the minimal level of sales for the silicon enterprise as part of Kawasaki Steel?

[Answer] Silicon wafers do not make a salable product by merely lowering the price. We have to pass the test of quality first; we have battles to wage there before dealing with price. Nevertheless, we may perhaps also need to provide some advantage in price because we are a newcomer.

With steel manufacture far surpassing the silicon enterprise and others in the entire operation of Kawasaki Steel, the silicon industry does not contribute any notable sum to the total unless it is combined with some other enterprises; the silicon industry will not make anything in a short time. The sale of silicon may be estimated, for example, on the basis of the present level of the Japanese market of around ¥200 billion and that of ¥500 billion in 4 to 5 years, as 10 percent of the market or ¥50 billion at the minimum. Every newcomer may have similar calculations, I suppose.

Mitsui Mining, Smelting

Tokyo KINZOKU JIHO in Japanese 5 Jul 86 pp 238-240

[Interview with Toru Kunkita, a managerial director of Mitsui Mining and Smelting Corp.; interviewer, date, and place not specified]

[Text] [Question] It is felt that the high yen has inflicted the heaviest impact on nonferrous metal mines. Would you tell me the extent of the impact and possible countermeasures?

[Answer] The extent of the impact of the high yen varies with industries; some industrial sectors may suffer gradually increasing impact whereas some will be affected immediately. The manufacture of base metals such as copper, lead, and zinc, the main product of this corporation, belong to the latter. The impact here is direct because international prices of these metals in dollars are converted into yen to set their daily and monthly prices. Kamioka and other mines where they smelt ores dug from their own mines are particularly obliged to suffer the fall of these metal prices wholly as a loss in profits.

Except for the gold bought and stocked, the nonferrous metal sector accounts for around 50 percent of the total sales of this corporation, with the remaining half being made up of the other processed materials, chemical, and synthetic products, new raw materials, etc. As can be seen, block metal manufacturers still have a very heavy share and, hence, the impact is all the more serious. To make the matter worse, we saw international market prices

of base metals bogged down prior to the attack of the present wave of the high yen; our corporation, therefore, as you know, has been forced to plan a rationalization centered around zinc undertakings.

As has already been reported, the contents of the rationalization involves an employee cut of around 600 or around 14 percent of the total, suspension of the production of block zinc at the Miike smeltery, separation of Kamioka Mining and Smeltery and Hikojima Smeltery plants into independent corporations, among other things, and, with an agreement reached with the labor union, the plan is being implemented. A cut in salary is also being executed for all employees for the current business year.

If one were assured that the current wave of the high yen was a temporary phenomenon, he would take refuge somewhere and have the wave pass by, like the attack of a typhoon. We, however, have not reasoned that way and hence the above countermeasures of rationalization was nevertheless set up at an exchange rate of ¥180 against the dollar. However, the high yen since then has advanced further and may conceivably settle at the ¥160 level, making the impact most grave.

Furthermore, it is very difficult to predict the manner in which the present high yen will affect every sector of industry. The high yen has advanced to such a degree that the difficulties involved are no longer limited to the base metal industry. One can predict neither how the Japanese economy as a whole will undergo changes nor how the industries other than those of the base metals and industries using these metals will be affected. With the rate of exchange of yen against the dollar so high, the Japanese economy as a whole must be forced to undergo major changes, but it is still not possible to predict at what level the yen rate will settle and what change in the industrial structure it is going to produce.

Note: At the time of this interview, the exchange rate was ¥160 to \$1.00.

Appropriate Support Measures Desired for Maintenance of Mining Enterprises Which Extensively Influence Local Economies

[Question] The current high yen may conceivably affect industry more than the previous oil shocks, which produced changes in the industrial structure. What countermeasures for the industry, do you think are necessary?

[Answer] The difficulty involved is that the current wave of the high yen is at levels higher than for the previous one and lasting longer. It is ardently and seriously hoped that the government will take appropriate measures against the rapid and continuing rise of the yen. With the core of the problem being the unbalanced trade account of the nation, it does not seem to resolve the problem to merely fumble the exchange rate, leaving the unbalanced trade account as it is, does it? The fundamental solution, I suppose, can not be come by unless the government makes some practical changes in relevant policies for expanding domestic demands. With prices of imported goods including that of crude oil having fallen, the surplus in the trade account will grow larger and larger under the circumstances, thereby letting the

economy bog down. It is necessary to take measures to uncover the very cause. However, Mitsui Mining and Smelting, for its part, is not allowed to mark time by merely awaiting government measures to save us. We have to take countermeasures of our own with dispatch and hence the big rationalization plan, which is inevitable to ride out the rapid progress of the high yen rate. A more lenient measure would have been possible if the high yen had made progress gradually over a long period, allowing prospecting for the extent of the current high yen.

The high value of the yen has advantages as well as disadvantages. Corporations, nevertheless, now see its disadvantages alone expanding whereas its advantages have yet to emerge to any appreciable extent; this is indeed unbearable for them. The electric power companies have currently been enjoying the most of the high yen. With the electric charges for industry raised by as much as 80 percent at the time of the revision of electric charges in 1980, the product between the exchange rate of the yen and the price of crude oil has presently fallen to a value less than half of that at that time. It is quite reasonable, therefore, to have electric charges brought down greatly.

It is also hoped that the government will render practical aid to domestic mines. Many of the domestic mines have communities which have developed around them. Mining enterprises exert an enormous influence on the community for which they bear a responsibility. After all, aid from the government to these mines is necessary because if these mines fold, the communities also fold.

If a mining enterprise is to prosper, the smelting enterprise needs to be profitable. The nonferrous smelters need to be profitable by any means since Japanese mines are not competitive enough to find a market abroad for the ore they produce. Cuts in electric charges are an important element in connection with this. The burden of the price of electricity in the total cost is overwhelmingly heavy, as is true also in terms of international competition, and any domestic smeltery with such a handicap is hardly capable of survival.

It is essential for Japan to keep international competitive power since it lacks natural resources and has to depend on foreign trade for survival. It would be awful if Japan absorbed itself in window dressing because of the external pressure and left the inside structure of its economy growing rickety. Corporations, meanwhile, are unable to find enough time to adjust themselves to the changing situation because the rise of the yen has been too rapid. It is therefore hoped all the more that the government will take appropriate measures in order to aid them.

Development of Products in the Downstream Area of Manufacturing Aimed at While Avoiding Competition With the User

[Question] The corporation seems to have made substantial efforts for the improvement of its constitution related to its undertakings in new raw materials. Would you tell me how these efforts are going?

[Answer] The improvement of the constitution of our corporation involves reduction of the portion of sales occupied by nonferrous block metals which presently accounts for 50 percent of the total, whereas the portion of chemical and synthetic products, processed products, and new raw materials will be expanded; this is a policy which our corporation has executed to date and which must accelerate.

The block metal sector is slated to undergo the current rationalization. This is a passive way of tackling the problem, which alone, however, will not work. In order to forge out a positive plan, therefore, we have set up various committees and are studying tentative means of consolidating our management. Nevertheless, as referred to above, the problem still remains unforeseeable because we can predict neither the extent of the present rise of the yen nor how the user will react under the circumstances.

Where the new raw material section is concerned, the Copper Foil Department and the New Metal Department posted, for the business year 1985, sales of around ¥23 billion or a meager 8.5 percent, which must be expanded.

[Question] I see the corporation placing substantial emphasis on copper foil. I would think, however, that such a processed product must be negatively affected by the shaky condition of nonferrous metal smelting, the base industry.

[Answer] Smelting of copper does not necessarily have a direct correlation with copper foil manufacturing; nevertheless, the high yen rate has an extended effect on copper foil. With copper foil used as a substrate for electronic components, changes in the circumstances of international competition for electronic components is the key to the problem. If the user reassesses relevant costs on the basis of the present high yen, they will necessarily make demands for cuts in the price of raw materials. Users have actually made demands for price reduction for almost all merchandise.

Furthermore, users will intensify their shift of production to nations abroad and we must keep an eye on these moves as we take necessary countermeasures. The copper foil enterprise was the first to take measures for overseas production; for example, it set up a joint corporation in the United States and built a plant in Formosa, even though its main plant operates in Japan. Hence, other enterprises of our corporation will also have to pursue the overseas production.

[Question] For electronic cell raw material, for example, you have extended the range of raw materials to lead, manganese, and lithium. Do you plan to expand your enterprises in, say, width of this level. Alternatively, do you want to expand your enterprises downstream from the present ones to ones such as those represented by FPC (flexible precision circuit substrates) manufacturing?

[Answer] Our commodities being turned out are expanding in range. The direction in which they are expanding, however, is not generally definable. The raw materials for electronic cells produced by our corporation have grown in

diversity because our corporation has long engaged in this type of research. Electronic cells, nevertheless, do not make a high-growth product. We plan here to adapt our products to the changing qualities and performances required, for example, long life of cells and specific applications of cells, and this is why the Research Institute for Raw Materials for Electronic Cells has been set up.

Embarking on FPC manufacturing, set up by the Mitsui Mining and Smelting FPC Corp., financed exclusively by Mitsui Mining and Smelting, does not imply that the corporation plans to engage in integrated manufacturing from raw materials (the upstream), or to the final products (the downstream). Such lengthwise manufacturing systems, if undertaken at all, would involve direct competition with our customers. In the case of FPC, copper foil manufacturing is followed by laminate plate manufacturing and FPC manufacturing, in that order. The corporation does not intend to start competing with its direct users. It should be admitted, nevertheless, that, if new products are to be developed, it must belong largely to downstream areas.

Sales Target for Non-Block Metal Sector Is 60 Percent

[Question] Would you tell me to what level you plan to increase the new raw material portion of sales over the long term?

[Answer] Our corporation has also mapped out a long-term scheme for its operations up to the year 1990, involving reduction of the production of the block metal section to 40 percent of total sales and expansion of the other sectors to fill the remaining 60 percent per year. Nevertheless, providing the present high yen leads to major changes in the economic environment, reevaluation of the plan may be necessary; we are embarking on that task.

With the conditions for exports growing less and less favorable due to the high yen, trade friction, etc., even new raw materials may not be sufficiently competitive if they are easy to turn out. Development of a product which either surpasses the others in quality or one involving high-grade technology is necessary, which in turn, must be based on the ability of creating new products by combining a number of technologies. With 4 years having passed since the start of the research and development headquarters, we see a number of individual key technologies having grown, which, when combined properly, may conceivably permit development of a distinctly superior product.

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NUCLEAR DEVELOPMENT

PARTIAL REVISION OF REGULATORY LAW ON ATOMIC REACTORS DISCUSSED

Tokyo PUROMETEUSU in Japanese Nov 86 pp 56-57

[Article by Masafumi Yamamoto, Atomic Energy Safety Section, Atomic Energy Bureau, Science and Technology Agency]

[Text] During the last regular session of the Diet (the 104th session), a partial revision of the regulatory law on atomic reactors and related matters was concluded and was promulgated on May 27.

This revision comprises two main parts, the formulation of regulations regarding disposal of radioactive wastes and actualization of an inspection system for atomic energy facilities. A summary will be presented in what follows.

1. Creation of Regulations on Disposal Business

(1) According to the existing law, radioactive waste that is generated in connection with the atomic energy activities is chiefly the charge of the respective atomic energy facility. The accumulation in the so-called low activity radioactive waste area amounts to about 630,000 barrels of drum cans as of the end of FY85. In addition, the so-called high activity radioactive waste that is generated accompanying the reprocessing of the fuel, although it is quantitatively slight at present, is expected to be returned from United Kingdom and France to which the reprocessing was consigned.

These wastes are to be disposed of for the time being according to the basic policy set forth by the Atomic Energy Commission. Namely, the low activity radioactive waste is to be disposed of by burying it in a shallow stratum, and the high activity radioactive waste is to be stored for cooling for 30 to 50 years prior to disposal.

In Rokkasho Village in Aomori Prefecture, plans for construction of waste processing and disposal facilities as a part of various facilities for nuclear fuel cycling, are in progress through an enterprise funded mainly by electrical businesses.

This revision is intended to enforce better regulations for processing and disposal of radioactive waste, in view of the new situations described above.

(2) More specific contents of the revision are as follows:

a. The law stipulates that those who intend to engage in the following two kinds of waste businesses have to obtain approval of the prime minister.

(i) Waste burying business--Final disposal business according to the burying method as set forth by government ordinance. (By stipulating government ordinance, opinions of both of the Atomic Energy Commissions have to be obtained, and the legal requirements of burying radioactive waste are expected to be set forth.))

(ii) Waste control business--Business which is set forth by government ordinance for control or processing before final disposal of the waste.

b. The prime minister must obtain and pay sufficient attention to opinions presented by both of the Atomic Energy Commissions before granting approval to the business in item a (double checking function).

c. For waste burying business and waste control business which were granted approval there apply predetermined regulations depending upon the mode of respective businesses. (See Figure 1)

(i) For waste burying business, it is obligated to receive confirmation before burying whether the waste itself to be buried satisfies the set standards, and whether the burying facility or related measures meet the standards. In addition, it is obligated to set up safety measures, get approval on the safety regulations and observe them.

(ii) For waste control business, it is obligated, from the viewpoint that the soundness of the control facilities is of paramount importance, that approval has to be obtained as to the design and the construction method of these facilities, that the facilities may not be used unless they pass the pre-use inspections, and that the facilities have to receive periodic inspections after initiation of their use. In addition, obligations on safety measures and safety regulations are to be charged similarly.

(3) Moreover, a waste business within the purview of the regulations on atomic reactors and others will be considered an atomic energy business within the purview of the atomic energy loss indemnity law. Therefore a partial revision to the atomic energy loss indemnity law was introduced to the effect that faultless indemnity liability on atomic energy losses that were caused in connection with the waste business will be charged to the waste business.

2. Solidification of Inspection System of Atomic Energy Facilities

(1) As is well known, major atomic energy facilities cannot be put to use until they pass pre-use inspections.

Now, the amount of the inspection business has been increased suddenly due to construction start of the fast breeder Monju and others. In order to be able to secure safety through careful inspections given at appropriate times, the

Figure 1. Regulation System for Waste Businesses



present situation necessitates active use of an inspection organ which is formed by consolidating the powers of the specialists in the private sector.

(2) In view of the above, as to the welding inspection which became routine and whose standards are well known, decision was made that it is separated from the pre-use inspections and the like, and an arrangement was made to have a part or whole of the inspection delegated to designated inspection organizations. Appointment to a designated agency is to be made to public service corporations which possess required capability and which make application for the job. Provisions are included in the revised law to the effect that a strict supervision will be given even after designation to the job is granted.

At the same time, welding inspection was required by the equipment makers in addition to the atomic energy businesses.

(3) Regarding the businesses for confirmation of transportation of nuclear fuel materials and the like and for confirmation of disposal of radioactive waste, their routine portions were made executable by designated confirmation organs. To the designated confirmation organs, the provisions for the designated inspection organs were made applicable.

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NUCLEAR DEVELOPMENT

MIDTERM REPORT ON R&D PLANS FOR HIGH TEMPERATURE GAS REACTOR

Tokyo PUROMETEUSU in Japanese Nov 86 pp 58-59

[Article by Iomohiro Yamano, Office of Atomic Energy Research and Development Organs, Atomic Energy Bureau, Science and Technology Agency]

[Text] The Special Committee on Research and Development Plans for high Temperature Gas Reactor of Atomic Energy Commission presented an interim report to the Atomic Energy Commission on 12 August.

1. Background

Research and development on a high temperature gas reactor in this country has been in progress for the design of an experimental reactor and related research by Japan Atomic Energy Research Institute (JAERI), based on long-term plans for atomic energy research and utilization (set forth on 30 June 1982), with accumulation of technical knowledge required for the construction of the experimental reactor. Changes in the social climate surrounding the high temperature gas reactor such as the demand trend for the utilization of nuclear thermal process, following the establishment of the long term plans, are conspicuous, so that there arose the necessity of newly examining and evaluating the future plans for research and development on the high temperature gas reactor.

Because of this Atomic Energy Commission established a special committee on research and development plans for high temperature gas reactor in March of this year. The special committee has considered and examined the trend of demand for utilization of nuclear heat, significance of research and development of high temperature gas reactor, future ways of advancing research and development on high temperature gas reactor, and so forth, and summarized them in an interim report.

2. Summary of Interim Report

(1) In this country, since 1969 research and development on the elemental technologies for high temperature gas reactor such as reactor physics, reactor engineering, fuel and materials, and high temperature equipment, and the design of the reactor have been advanced with JAERI as the center, obtaining many excellent results. Therefore, the technological basis for initiating the

construction of a reactor with output of about several tens of Mwt is completed.

On the other hand, as to the utilization of high temperature nuclear heat produced by high temperature gas reactor in industries such as chemical industry and steel manufacture, there exist technological forecast, but it is not in a situation in which its economy can be established in the near future (within the current century).

(2) Accordingly, the plan for constructing an experimental reactor which is one step toward early realization of high temperature gas reactor that is presented in the current long-term plans is in a position to be revised.

(3) However, high temperature gas reactor is a type of reactor which possesses excellent features such as supply of high temperature heat, characteristically high safety, high degree of combustion, and so forth, so that the promotion of its research and development is very significant in that it can contribute toward the solution to important problems for the development of atomic energy like extension of application field, improvement of thermal efficiency, and improvement of economy, under very secure conditions. Therefore, it is necessary to firmly establish the basis for its technology and to expand its future advancement.

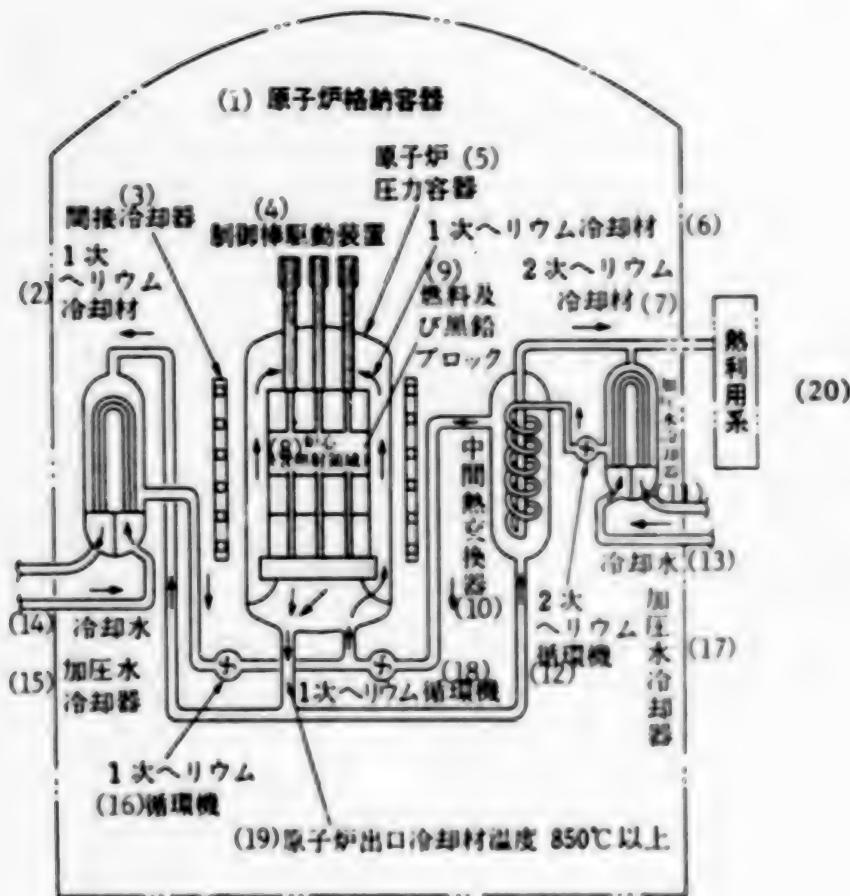
(4) Universities, national testing and research organizations, and others wish to carry out advanced basic research concerning high temperatures by the use of the high temperature gas reactor facility through high temperature irradiation experiments for large-sized samples of ceramic materials and nuclear fusion materials. The research is expected to create seeds of various kinds of new technologies that may become a turning point for technological innovation in the field of materials science and technology.

(5) Therefore, it is appropriate to construct a high temperature gas testing and research reactor as soon as possible, as a facility for carrying out various kinds of advanced basic research concerning high temperature and for realizing advancement and establishment of high temperature gas reactor technology.

(6) In connection with that, it is important to establish an independent technology for designing and constructing a reactor on its own and operate it to obtain data, based on the technologies that have been accumulated in this country.

(7) Functions the test reactor should have include: providing an irradiation zone within the reactor to allow various kinds of irradiation tests such as the fuel puncture test and the irradiation test with instruments; raising the temperature at the reactor outlet stepwise from about 850 degrees C which is achievable by the current technological level; and having a reactor output of about 30 Mwt which is appropriate.

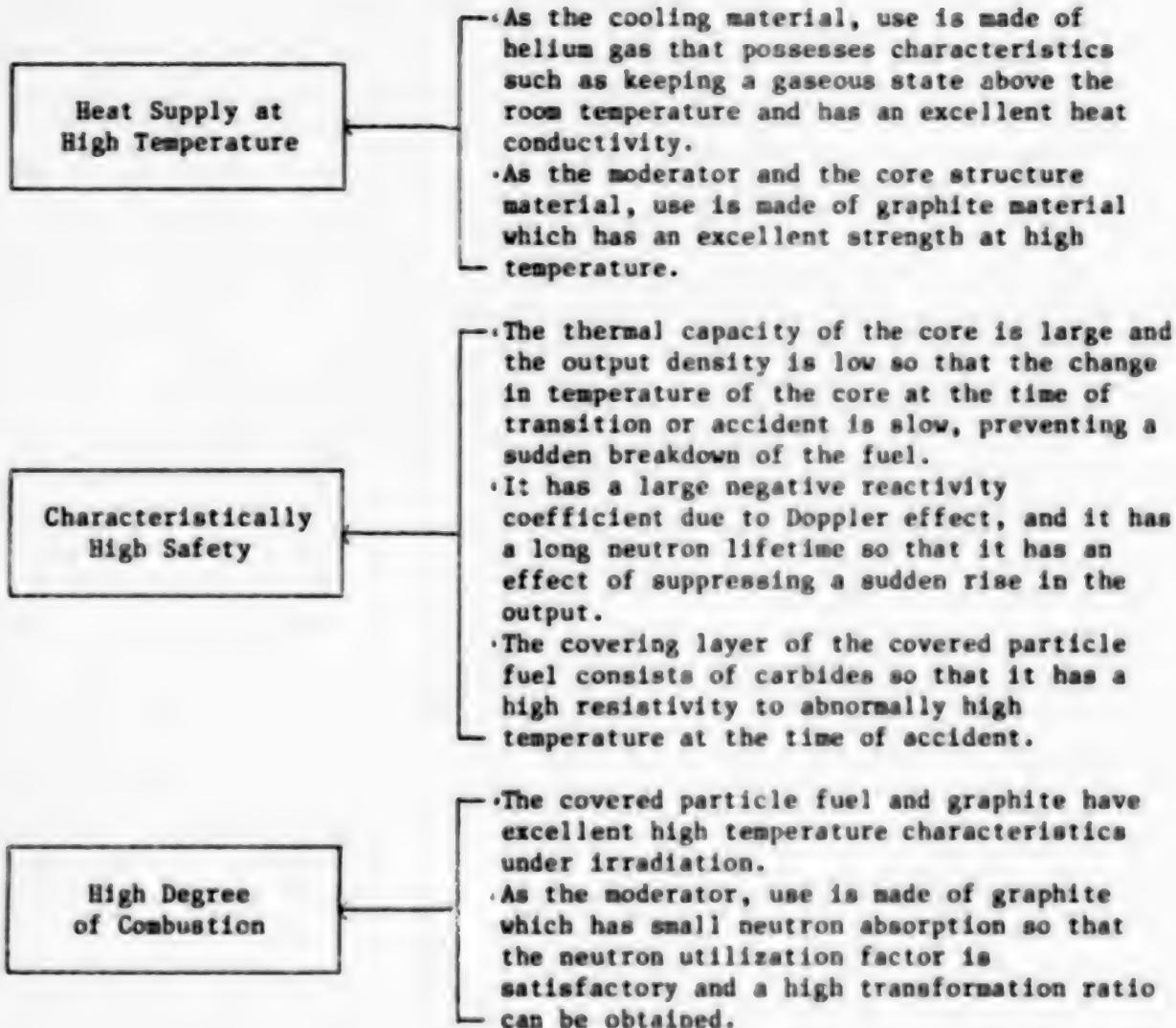
(8) Research and development for the high temperature gas reactor should be performed not only with the participation of universities and national testing and research organizations, but also with a wide cooperation from industry. In



Key:

1. Reactor container vessel
2. Primary helium cooling material
3. Indirect cooler
4. Driving device for control rods
5. Pressurized reactor vessel
6. Primary helium cooling material
7. Secondary helium cooling material
8. Reactor core (including irradiation zone)
9. Fuel and graphite block
10. Intermediate heat exchanger
11. Pressurized water cooler
12. Secondary helium circulator
13. Cooling water
14. Cooling water
15. Pressurized water cooler
16. Primary helium circulator
17. Pressurized water cooler
18. Primary helium circulator
19. Temperature of cooling material at reactor outlet more than 850°C
20. Heat utilization system

Characteristics of High Temperature Gas



addition, the high temperature gas reactor will become a unique facility in the world so that international cooperation with foreign countries should be carried out actively.

(9) On the other hand, development of the utilization technology of the nuclear thermal process needs be carried out in a well-planned manner by taking into account the trend concerning the utilization of the nuclear thermal process.

(10) Further, in carrying out future research and development of high temperature gas reactor, it is important to push it with evaluation of research results at important turning points.

3. Response of Science and Technology Agency

Upon receipt of the interim report, the Science and Technology Agency decided to construct a "test and research reactor for high temperature engineering" for the purpose of establishing and advancing the basis for the high temperature gas reactor technology and carrying out advanced basic research concerning high temperature. Toward that goal, the agency is requesting Y788 million in the budget request for FY87 as a preparatory cost toward construction of the reactor to cover expenditures necessary for preparation of safety examination.

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TELECOMMUNICATIONS

NTT'S 'MICROWAVE 400 M. METHOD' DOUBLES TRANSMISSION CAPACITY

Tokyo TSUSHIN KOYO SHIMBUN in Japanese 10 Nov 86 p 2

[Text] NTT has been putting a great effort into transforming microwave systems into digital formats, and they have announced that, following on the 16 quadrature amplitude modulation (QAM) microwave formula (4-, 5-, 6-G--200 M system) which they are currently introducing, they have succeeded in site tests with a 256 QAM "microwave 400 M. system" which doubles the volume of traffic (5,760 telephone exchange circuits). This amounts to the final manufacturing test and final site test of the equipment and its commercialization; all this aimed at completing development in 1988 of the basic technology for the transfer to digital technology of long distance microwave trunk lines.

Success was achieved in September 1984 with laboratory transmission tests with this system at the Yokosuka Laboratory (so-called at that time); but the current on-site experiments were intended to demonstrate the applicability of digital microwave systems using 256 QAM by bauded transmission experiments along the radio relay section (from Chichibu'shigakubo to Nakano in the Kanto, or 54.6 kilometers; and from Kobe-Oski to Kishiwada in the Kansai, a distance of 33.4 kilometers).

In comparison with the 16 QAM system, the new system achieved a transmission capacity of 5,760 circuits, which doubles the transmission capacity of 2,880 circuits of the 16 QAM system; this is achieved by doubling the transmission volume from 200 megabits/second to 400 megabits/second and the frequency multiple-use efficiency from 5 bits/second/hertz to a world-best of 10 bits/second/hertz, all within the same frequency band.

Moreover, with the relay distance of 50 kilometers, the same as the 4-, 5-, 6-G 200 M digital microwave system, the existing relay stations and steel towers can be used; therefore it is possible to construct long distance transmission routes at low cost. It looks as if this system will play a vital role in digital communications networks in tandem with the "F-400 M optical transmission system" to be used in optical fiber circuits.

The following four new technologies were developed in order to bring this technique to fruition:

1. High precision 256 QAM modulation/demodulation technology. This involved designing major components as integrated circuits (IC), the new development of circuits to automatically correct fluctuations, and the achievement of increases in precision greater than 5-fold in comparison to 16 QAM. This technology also brought into existence high precision 256 QAM modulators/demodulators using error correction circuits.
2. Phasing compensation technology. As technology that compensates for waveform distortions arising from "phasing phenomena," which are fluctuations in the reception conditions due to atmospheric conditions, this narrows the signal bandwidth for each electromagnetic wave, and it uses "multi-carrier technology" that narrows the signal bandwidth for each electromagnetic wave and processes many electromagnetic waves simultaneously. In addition, success was achieved working out transversal equalizers and increases in the capabilities of "space diversity" (a method for receiving that improves quality using spatial correlations of the antennas).
3. Interference compensation technology. The primary interference noise is interference from existing radio systems; this is interference between vertical and horizontal polarizations coming from phasing and antennas (polarization interference), and that arising at relay stations where microroutes are concentrated. To alleviate this, polarization interference compensation devices and VCD (vector correlation detection) type interference compensation devices were developed.
4. Low distortion high power amplification techniques. To compensate for distortions of the signal generated by the amplifiers in transmitters, miniature high capacity distortion compensation devices were developed, and it was possible to achieve high power amplification and to reduce heat noise.

/9599
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TELECOMMUNICATIONS

KDD MOVES TOWARD HIGH-SPEED DIGITAL LEASED SERVICE

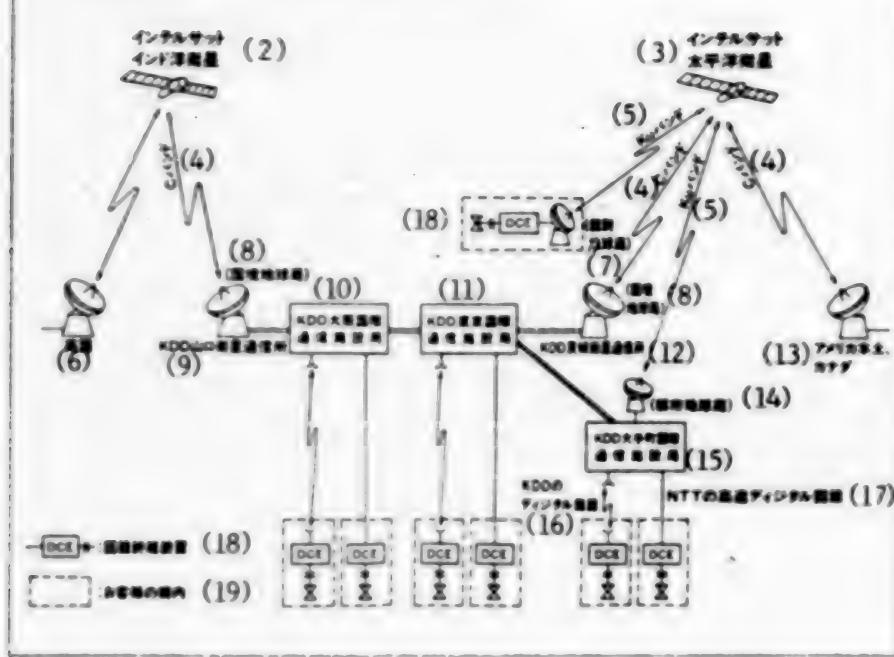
Tokyo TSUSHIN KOGYO SHIMBUN in Japanese 8 Dec 86 p 2

[Text] Japanese international communications are finally trying to move into the age of competition by hurrying quickly into the construction of a "second KDD" (Kokusai Denshin Denwa, Japan International Telephone and Telegraph) operating firm. As a part of this, KDD will begin in the middle of this month to sell high-speed digital leased-line services using "IBS," the new type of satellite communications media offered by INTELSAT (International Telecommunications Satellite Consortium). This is designed to respond to demands for new communication services in the new media age, including international television conferencing, high speed transmission of paper pages, and unified digital communications. These are epoch-making services that will cause the international leased services traditionally available to increase greatly. It has been noted that in the near future this will provide a new satellite communications medium that will make it possible to supply services by direct transmissions between the INTELSAT communications satellites and miniature earth stations built by the IBS users, and that it will greatly increase the volume of international leased-line services. And this really amounted to the beginning of leased services running through "urban earth stations."

IBS (INTELSAT Business Service) is a new type of satellite communications medium from INTELSAT. INTELSAT has provided communications satellite circuits to the communications carriers of the various signatory nations in the INTELSAT consortium, and IBS was started so INTELSAT could provide large-volume high-speed data transmissions by large final users (especially businesses). IBS represents a new type of satellite communications medium which will not only provide services along paths between earth stations built mainly by the communications carriers until now, but also makes possible types of services based on direct exchanges of transmissions between the INTELSAT communications satellites and small-scale earth stations built by customer users within their own facilities.

With KDD's international leased-line services, 54 kilobits/second is the fastest of the coding classes, but if the medium is used, not only will it be possible to use seven speeds, including 64 kilobits/second, 128 kilobits/second, 256 kilobits/second, 384 kilobits/second, 768 kilobits/second, 1.5 Megabits/second, and 2 Megabits/second; it will also be possible to provide

—国際高速ディジタル専用回線の回線構成— (1)



Key:

1. Make-up of Circuits for International High-Speed Leased Circuits
2. INTELSAT Indian Ocean Satellite
3. INTELSAT Pacific Ocean Satellite
4. C band
5. Ku band
6. United Kingdom
7. Individual earth station
8. Boundary earth station
9. KDD Yamaguchi Satellite Earth Station
10. KDD Osaka International Communications Facility
11. KDD Tokyo International Communications Facility
12. KDD Ibaraki Satellite Earth Station
13. Continental United States, Canada
14. Urban earth station
15. KDD Otemachi International Communications Facility
16. KDD's digital radio
17. NTT's high-speed digital circuit
18. DCE: circuit terminal equipment
19. Within customer facilities

new digital imagery communications services such as international television telephones and international television conferences. IBS is said to be an international communications medium suited to the new media era.

The form of provision of service that most gives rise to the characteristics of these IBS media is the fact that major users will have direct access to the satellites. KDD has considered such factors as the size of the demand for communications of the various users and user regions, the interference with terrestrial microwave systems, geographical conditions, and the degree of development of terrestrial digital networks. They are predicting that they will be able to offer services over three types of earth station routes, here presented in their order of introduction: (1) routing via urban earth stations, (2) routings via national boundary earth stations, and (3) routings via individual earth stations. These are characterized (by KDD's main office) by saying "these are classifications in terms of circuit composition, and even if there are some differences in part of the terms of the provision of service, they are all the same service in terms of providing high-speed digital leased circuits which at present are value added items in the international leased-line services."

Urban Earth Station Routing

KDD has built medium-scale earth stations within the KDD compounds within major urban areas, and by using this as a gateway station (there are also international maintenance centers), it provides high-speed digital leased services mainly to users in that region. Initially they will only start service in the Tokyo region where demand is heavy. A standard medium-sized E2 antenna (diameter 5.5 meters) has already been built on the roof of KDD's Otemachi building in Tokyo, and it can access the INTELSAT V Pacific Ocean region satellite (134 degrees east longitude). The frequency band used is the Ku band (11/14 GHz).

Along the domestic circuits between the gateway station and the user's facility, the circuits used as the high-speed bauded types (48 kilobits/second and 56 kilobits/second) traditionally used for international leased circuits, or, similarly, NTT's (Nippon Telephone and Telegraph) high-speed digital circuits; but beyond that preparations are being made to permit the use of digital wireless which KDD will provide. In either case KDD installs circuit terminal equipment with CCITT standard interfaces. KDD has already filed the application with the Ministry of Posts and Telecommunications (MPT) for permission for this kind of service, and it is forecast that this will be approved in the middle of this month (December 1986) after approval by the Electric Communications Advisory Committee.

According to the application, the categories of service will include eight varieties ranging from 64 kilobits/second to 2 Megabits/second, and the areas served will include the United States and Canada initially. The first service will be within the Pacific Ocean region. Within a year this will start with the UK as well, and it is forecast that this will expand to regions for which agreements can be made with the partner countries. The fees (the portion on

the Japanese end) will be Y1.41 million per month to the continental United States and Canada for a 64 kilobit circuit, while similar service to the UK will be Y1.88 million per month; 128 kilobit service will be Y2.45 million and Y2.84 million respectively, with charges of Y3.24 million and Y4.32 million respectively for 256 kilobit service, Y4.13 million and Y5.51 million respectively for 384 kilobit service, Y4.91 million and Y6.55 million per month respectively for 512 kilobit service, Y6.26 million and Y8.35 million respectively for 768 kilobit service, Y9.49 million and Y12.66 million per month respectively for 1.5 Megabit service, and Y10.85 million and Y14.47 million per month respectively for 2 Megabit service. Through the introduction of these services the cost of service for the present international high-speed bauded transmission leased circuit (48 kbit and 56 kbit) will be reduced an average of 35 percent, bringing the cost of a 64 kilobit circuit to the same level.

The fees for the use of the domestic portion of the circuits will be roughly comparable to the fees for the use of leased circuits for NTT's high-speed digital transmission service, and the monthly fees for the use of circuit terminal equipment installed in the user's facilities will be Y28,800 for 64 kilobit service, Y36,000 for 128 kilobit to 1.5 Megabit service, and Y54,000 for 2 Megabit service.

In addition, it has been decided to commence international television conference call service using IBS, and this will provide service between the television conference room in the foreign country and either the public use conference room built in the first floor of KDD's Otemachi building or the user's specialized television conference room. The regions that will be handling this are the continental United States and the UK, and the costs for the use of the international circuit segment (Japanese share) will be Y80,000 for 30 minutes to the United States and Y110,000 for 30 minutes to the UK. Its appearance is highly desired as an effective new communications service that will increase the vitality and efficiency of the activity of firms, it is said, and this is coming about as a result of IBS.

Routing via National Boundary Earth Stations

For a long time, high-speed digital leased service has been provided through the large earth stations (In the case of the standard A, the antenna diameter is 30 meters.) located at KDD's Ibaraki satellite earth station and KDD's Yamaguchi satellite earth station, which are the international communications bases linking Japan with the Pacific Ocean region satellite and the Indian Ocean region satellite. If service were expanded beyond the urban earth station routings, national boundary earth stations would play a role in substituting and complementing the volume of circuits running through urban earth station routings.

The planned frequency is the C band (4/6 GHz), and the introductory period is planned for spring 1987 for the Indian Ocean route and autumn 1987 for the Pacific Ocean route. The gateways are Tokyo and Osaka, which are the international control centers, and the segment of the domestic circuit leading

to the user's facility will be the same as for the routing to the urban earth station, at the present time using NTT's high-speed digital circuits.

Routings Through Individual Earth Stations

This would be a configuration in which high-speed leased digital service would be provided by KDD building small-scale earth stations (antenna diameter 3.5 meters for a standard El antenna) within the user's premises rather than within KDD's premises. Accordingly, in contrast to the routing through the urban earth stations and the routing through the national border earth stations, the domestic part of the circuit is unnecessary, and this is a major characteristic of this system.

The intended recipients of these services will be heavy users demanding circuits on the Megabit/second class as well as users who cannot connect to digital systems within the country for geographical reasons. However, the premise is that there be no interference with terrestrial microwave. The band planned for use is the Ku band. Plans call for consideration and decisions regarding technological conditions (primarily the problem of electrical interference with terrestrial microwave) and development of demand for earth station types of services at the time of introduction.

In this way, high-speed international digital lease communications offered through IBS have been seen as the heart of the composition of the circuits in Japan; but if we examine the situation in other countries, we see that in the North American region (the continental United States and Canada), the first to inaugurate service, various communications carriers along the west coast are either building or plan in the next few years to build large-scale earth stations for IBS use via the Pacific Ocean satellites. They plan to use the C band. In addition, the various communications carriers are placing the gateway stations in places different from the earth stations. Since the centers of demand will not necessarily be in the same places as the areas where the earth stations are located, if we apply this to the types of services that will be available on the Japanese side, it appears the service on the North American side will correspond to the boundary earth station type of routing.

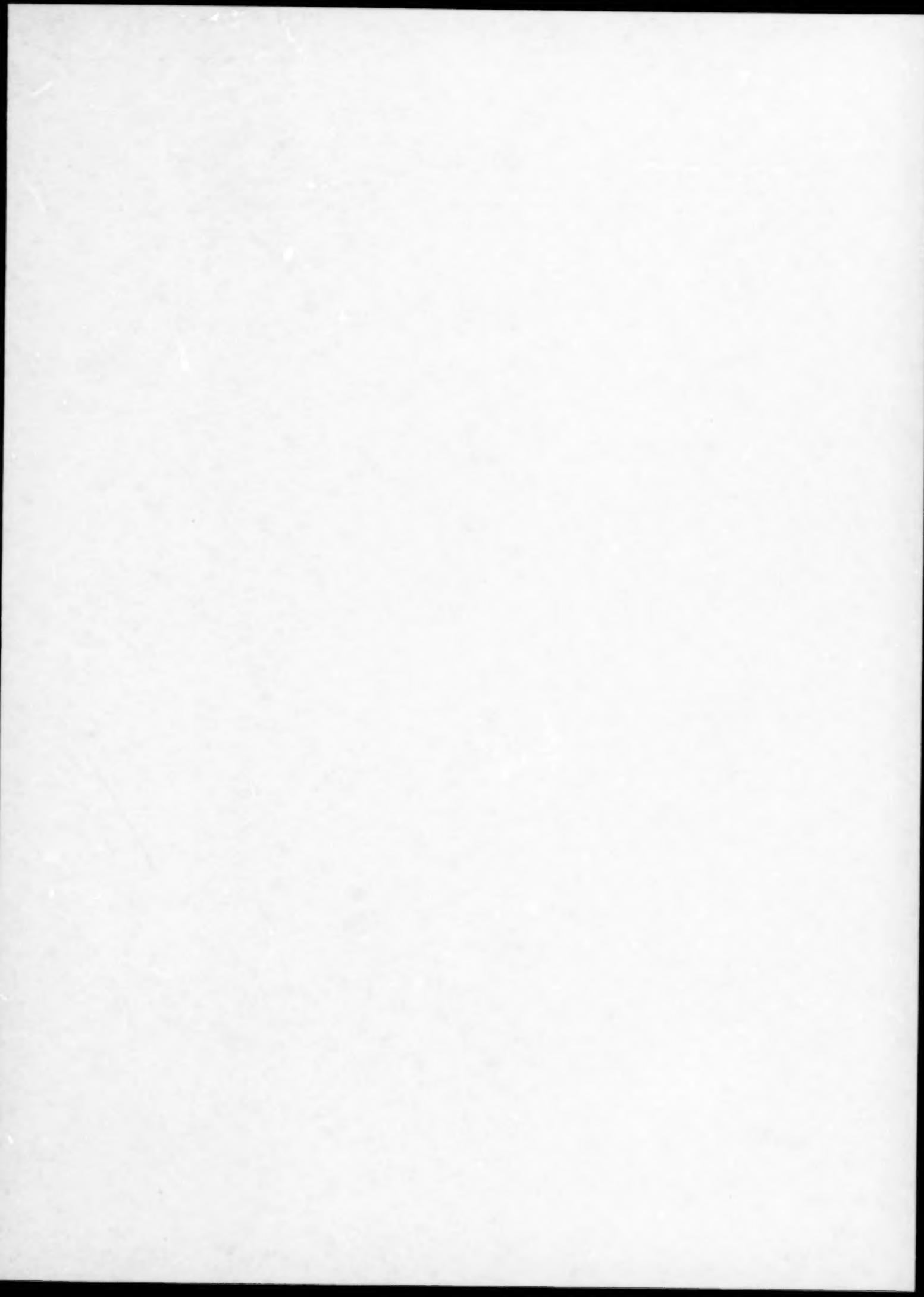
KDD has decided to begin service by initially designating the high-speed digital leased service based in this way on the IBS media as an additional class among the bauded classes of international leased line service; but requests and inquiries from the users have already been received, and there is great interest in IBS media. Requests have been especially numerous from newspaper firms, trading companies, manufacturers, and finance-related entities, and the first users will probably be from these groups. KDD is also investigating time-borrowing service; as soon as the needs are clear, KDD plans to bring this about if cooperation can be worked out with the concerned foreign telecommunications carriers.

In any case, in comparison with the 56 kilobit per second speed of the present international high-speed bauded circuits, the availability of international

digital high-speed leased lines using IBS will make possible speeds 30 or more times faster. Since use has started in fields requiring high-volume high-speed transmissions, such as teleconferencing, high-speed paper page transmission, and unified digital communications, Japanese international leased-line services have plunged into a new age.

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